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NATURAL HISTORY AND PATHOLOGY

OF

TRICHINOUS INFECTION

OF

MEN AND ANIMALS.

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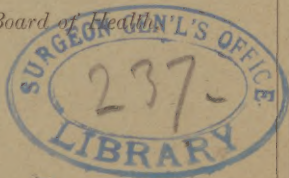
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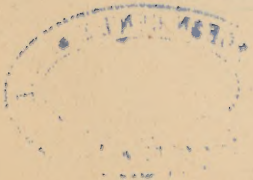
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NATURAL HISTORY AND PATHOLOGY OF THE TRICHINOUS INFECTION OF MAN AND ANIMALS.

BY NOAH CRESSY, M.D., V.S., PH.D.

Amid the various sources for the transmission of disease from the lower orders of animals to man, especially those of a parasitic origin, there is none more dangerous in character nor more loathsome and foreboding than the one caused by the presence of minute worms in the flesh of swine, which we are ever liable to consume. The increasing prevalence of this entozoic contamination of one of our staple products of food has awakened new zeal among the sanitarians both at home and abroad; but until the public mind is more enlightened on the subject, and the real nature and symptoms of this almost intractable malady better understood, we are ever liable to encounter new outbreaks, even under the most favorable circumstances, like the instance that occurred at West Hartford last winter.

In view therefore of the great liability of such a recurrence within the borders of our state, from want of adequate knowledge among our people, we deem it expedient and opportune, on this occasion, to treat the subject in detail, and thus set forth the natural history of the parasite and discuss the morbid changes that occur in the animal body when trichinous pork has been eaten in a raw or partially-cooked state. Such meat is now well known to be exceedingly dangerous as an article of food, and often gives rise to one of the most obscure and fatal maladies that the physician has to contend with in human practice. Hence the necessity for a more general diffusion of knowledge in this direction, that we may actually guard ourselves against this parasitic invasion of disease, and thus more accurately scrutinize the intent of those sensational and exaggerated reports from abroad, which have already unjustly compromised the honor and activity of one of our leading industries.



DISCOVERY OF THE TRICHINÆ SPIRALIS.

This parasite was first described and named by Prof. Richard Owen* of London, in 1835; and though frequently seen by scientific observers it was only regarded as a microscopic curiosity for more than a quarter of a century. His attention had been indirectly called to the subject some two years previously by John Hilton, demonstrator of anatomy at Guy's Hospital Medical College, who had observed a peculiar appearance of human muscle, and thought it depended upon the formation of very small *cysticerci*. He made a communication to the Medico-chirurgical Society in 1833, which was regarded with much favor at the time, and has now become historic in English bibliography, as the first published account† we have of the abode of the worm in question.

Dr. Warmald of the St. Bartholomew school had frequently observed the same abnormal and *specked* condition of certain muscles. The gritty sensation he had perceived and the blunting of the edge of his scalpel, in dissecting, caused him one day to mention the fact to Prof. Owen. This led to some inquiries concerning the nature of these little calcified bodies in the flesh, and the distinguished anatomist at once requested a specimen for microscopic examination, as seen at Fig. 1, from the next subject he should find thus infected. It was not long, however, before his wish was gratified; but ere he had time to investigate the matter, one of the students, now better known as Sir James Paget, the renowned pathologist, dissected some of these calcareous cysts, and with the aid of a microscope, which he borrowed of Dr. Robert Brown, the celebrated botanist, he actually saw this living entozoon first coiled upon itself and in a dormant state.

This discovery enlisted Dr. Brown's attention, and he accordingly rendered his student friend valuable assistance, by "dexterously pulling a worm from the cyst" for examination. Dr. Brown therefore first saw this interesting parasite in a free and larval state, liberated from its prison life.

Figure 1.



A portion of human muscle showing the cysts of the *Trichinæ spiralis*, natural size.

* Transactions of Zoological Society, Vol. I, page 315.

† See London Medical Gazette, Vol. XI, page 605.

Portions of this trichinized muscle having been "distributed far and wide," much interest was awakened in scientific circles concerning its natural history. The medical profession therefore very naturally turned their attention to Prof. Owen, who of all English naturalists was best prepared to throw a gleam of light on the subject. He found each capsule to contain from one to three small hair-like worms, invariably coiled up in a conical form; hence he gave it the very appropriate zoological name the parasite now bears. But, as this examination was made with a low magnifying power, he did not perceive that this little helminth had any internal organization. Consequently he arranged it among the lowest of the entozoa, in his new-made class *Protelmintha*.

SUBSEQUENT INVESTIGATION.

Dr. Arthur Farre* by his careful dissections soon distinguished an alimentary canal, which at once elevated the parasite in the classification of naturalists to the order of nematoid worms. Yet he was unable to decide which was the anterior extremity, and for nearly fifteen years there was no advance of anatomical knowledge on the subject.

It therefore remained for Prof. H. Luschka of Tubingen University, in 1850, to point out more accurately the internal structure. He carefully traced the digestive canal, discovered the sexual organs of the female, and conclusively proved that the mouth was situated in the pointed end of the worm, and not in the blunt extremity, as was generally believed. He described the cyst in its advanced stages, and demonstrated for the first time a complicated system of blood-vessels, and an external membrane of connective tissue by which it is surrounded. In his observations on the vitality of the trichinæ, he found that they survived putrefaction and freezing of the muscles.

Dr. Herbst, a German helminthologist, followed in this line of investigation, and his experiments on dogs actually solved the question concerning the propagation of trichinæ. He was the first to rear encapsuled flesh-worms in the muscular tissue, and claimed that in this state only they were transferable from one animal to another.

* London Gazette, Dec., 1835.

Dr. Kuchenmeister, having previously shown the transformation of measles or hydatid tæniæ into tape worms, was led to the supposition that the trichina might be a juvenile form of a known nematode; and after a series of observations, he declared that this flesh-worm was the larva of the *Trichocephalus dispar*.*

A new impulse was given to trichinal investigation in 1859, by Prof. Virchow's† experiments. He fed a dog upon trichinous meat, and in four days found a large number of these nematodes fully developed and sexually mature in the intestines, but he failed to observe the migration of the new-born worms which Herbst had previously demonstrated. This was owing partially to his having killed the dog too early, and also from the fact that he selected an old animal for the experiment, through whose firm tissues the young trichinæ scarcely ever penetrate.

Prof. R. Leuckart,‡ of Giessen, followed up the researches on the embryology of the parasite; he made a series of experiments on trichinal infection that were very comprehensive, and did much to advance the science of helminthology. He corrected his own previously-expressed opinion on the validity of Kuchenmeister's observation on the transformation of the flesh-worm into *trichocephalus*, and thus confirmed Virchow. He also showed that the young trichinæ in the intestines became the encysted worm in the muscles, as shown at Figs. 2 and 5, and he believed that they reached there by migration through the tissues, as graphically illustrated in Kestner's circular figure, on our fine lithographic plate. Others however claim that the distribution of the trichinæ over the body in so short a time can only be affected through the circulation of the blood.

Figure 2.



A portion of ham, showing two cysts of the *Trichina spiralis* enclosed, slightly magnified.

NATURAL HISTORY OF THE PARASITE.

These famous microscopic entozoa that so frequently contaminate our pork, and are known among naturalists as the *Trichina spiralis*, present in their evolution three well-marked stages of exist-

* Animal and Vegetable Parasites, Sydenham Ed., 1857, Vol. I, page 321.

† Cyclopædia of Anatomy and Physiology, Vol. II, page 126.

‡ For a summary of his views see Burk's translation in Quar. Jour. of Microscopical Science, Vol. VIII, page 168.

ence for us to study, which really anticipate the larva, pupa, and imago phases of development in the winged insects. The natural history of this flesh worm, therefore, becomes not a little interesting and worthy of special notice in this connection when we endeavor to explain the precise manner of its infection, the phenomena of certain symptoms, and the ultimate cause of death in the human victim.

The encysted worm that Owen described is now well known to helminthologists to represent the *larval* condition of an adult nematode. It detracts nothing however from the honor of his discovery, observes Professor Cobbold, that these little worms have turned out to be the wandering brood of a more highly-organized and dangerous parasite.*

The body of this flesh-worm is very slender and scarcely visible to the naked eye. It tapers anteriorly, and therefore the head is at the pointed end of the worm. The mouth is round, unarmed, and very small. The alimentary canal is straight, and is divisible into three distinct parts, corresponding to the œsophagus, stomach, and intestines.

The male is much smaller than the female, as will be seen in comparing them on the plate, under the same magnifying power. The tail of the male worm is furnished with two lateral appendages, well defined as seen at Fig. 2. The cloaca situated between these points is reversed during the generative act.

The adult female varies from three to four millimeters† in length, with the vulva situated near the end of the anterior fifth of the body, as represented at Fig. 5. There is but a single ovary, and the many ovules are plain to be seen through the smooth integument in various stages of development.

The sexually mature female is one-eighth of an inch in length, while the male is only about two-thirds that size. The female is ovo-viviparous, and thus brings forth its young alive, as seen at Fig. 4 on the plate. The young trichinæ begin at once to migrate from the bowels and perambulate the entire system of voluntary muscles, as portrayed in the circular figure. At last they become encysted, and there remain forever at rest, until they perchance shall have been eaten by some other animal, when they in turn will be set free, and thus complete a zoological cycle of existence.

It should be remembered that it is in the *encysted* state, as seen

* See his classic work on the Entozoa, *An Introduction to Helminthology*, Lond., 1869 page 335.

† .09 to .12 of an inch (nine to twelve hundredths of an inch.)

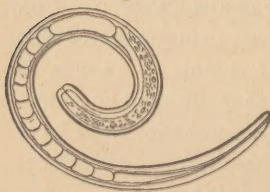
in 2 and 5 ; that the trichina is transported from one flesh-eating animal to another. Pigs are not born with these enzoota, but get them in some kind of food, probably from the flesh of rats and mice, and when once swallowed by the hog or other animal the gastric juice, in the process of digestion, soon dissolves this albumino-cretaceous cyst, when the parasite will be liberated from its prison life, and in a few days become a full-grown worm, within the stomach and intestines, ready to propagate its countless young.

The red voluntary muscles, says Dr. Thudichum, are the "promised land of the trichinae." There they migrate, grow, and enshrine themselves. Although the young trichinae, on the seventh day and later after infection, are found in almost all the organs of the body, yet they do not grow or become encapsuled in any other tissue. The trichinae, according to his observations, arrive in the muscular tissue with the blood. The diameter of the smallest capillaries in the muscles is much less than the diameter of the young trichinae, so they are certain to be arrested. They then penetrate the single or double coats of the muscles, and are at once in the interstitial spaces between the muscular fibers. Many trichinae unquestionably never enter the sarcolemma, and become encysted, but when they do the fibers become permanently destroyed. At the end of the third week after immigration, the inflammatory irritation of the muscular fiber has reached its highest point, the trichina is nearly full grown, and becomes fixed to the spot where it is to be encapsuled. Several of these worms may wander in the same track, and ultimately be enclosed in one lump of exuded matter.

This parasite, which undoubtedly infects a large number of animals, has frequently been found in the rat, mouse, cat, hedgehog, fox, mole, and hog, and is liable to be transmitted from one car-

nivorous animal to another through the meat. The Commission of the Royal College of Physicians of Vienna report that the main course of the infection in the hog is from the rat, and nearly one-half of all these vermin examined in Moravia were found infected with the encysted trichinae ; and it is not improbable, as Fleming observes, that the rats were primarily infected and have thus transmitted these parasites from one generation to another by virtue of their carnivorous habit at times to devour each other.*

Figure 3.



Trichina magnified one hundred times.

* Veterinary Sanitary Science.

But on the other hand the fact that rats around slaughter-houses are almost invariably infected, while those from distant farms are often found to contain no trichinae, leads us naturally to inquire whether the rat or the hog was the original host of this destructive parasite.

TRICHINIASIS IN ANIMALS.

The history and symptoms of this disease in the lower animals have not received that attention, in a sanitary point of view, which the importance of the subject demands. That the malady in question has often been mistaken for "Hog cholera," which at a certain stage it so much resembles, no one can doubt. In fact, many of the symptoms of the swine plague are so closely allied to those seen in experimental cases of trichinal infection that it must be exceedingly difficult at times, if not impossible, to draw the line of demarcation, which pathologically separates these two diseases, without a careful microscopic examination. It therefore becomes germane in the consideration of our theme to note some of the more prominent features of this parasitic affection that have been observed in experimental animals.

Professor Gerlach, of the Berlin Veterinary school, found that pigs from three to six months old became much more easily infected than those of a more mature age. In mild cases, the symptoms were not characteristic of much intestinal disturbance. The appetite, though somewhat capricious, was soon regained and the animal resumed its usual habits of life again.

But in more severe cases, where a larger amount of trichinized food had been given, the symptoms were well-marked and of a two-fold character. The loss of appetite, occasional vomiting, and the general depression that ensued, always served to indicate the initial stage of parasitic invasion. A diarrhea soon followed, attended with more or less fever, restlessness, and prostration, but these symptoms were often variable both in time and degree, according to the susceptibility of the animal. In young pigs, the gastro-intestinal irritation not infrequently proved fatal within ten days after feeding them with infected meat.

The second phase of the malady is indicated by rheumatic pains and soreness of the muscles, which appear in the second or third week, when the larval trichinae commence their migration through the tissues. These symptoms come on gradually, as the others dis-

* See his able paper on the subject in the 7th Public Health Report of the Privy Council, London, 1865.

appear, and thus vary somewhat in character, according to the group of muscles invaded by the parasites.

In this stage, hogs manifest a restless disposition, lying down and getting up again as if to change positions for comfort. They walk with a tottering gait, are stiff and unsteady in all their motions. Hence the reason why they seem to prefer to lie stretched out, as if to rest their weary limbs, from which position such affected animals often require help to rise.

When the muscles of mastication and deglutition are invaded, the hog manifests great difficulty in eating and it is often impossible for it to swallow even liquid food. Symptoms of lock-jaw therefore frequently supervene and thus become a serious complication, especially if the throat and the respiratory muscles are also affected. In such cases, the breathing is labored, and there is more or less wheezing. The voice of the animal, Gerlach noticed in several instances to change very materially, and it even became aphonic from the invasion of these parasites. Consequently, such afflicted animals have no power to squeal, even when disturbed.

The tongue and under lip are frequently swollen in some cases, and sometimes the cheeks and the muscles of the neck are also involved, giving a general oedematous appearance about the head. The eyes become suffused with tears, and the conjunctiva wears a reddened hue for several days.

With such a group of symptoms present, a shoat must lose condition rapidly and thus become very weak and emaciated in a short time. But the symptoms of experimental cases of trichinization, according to Gerlach, are quite variable, depending largely upon the quantity of infected meat that had been administered at one time. Where the quantity was small, the animal seemed to suffer but little from its effects, and yet after repeated trials he found the entire muscular system as thoroughly invaded with the parasites as where the quantity was large and thus produced severe trichiniosis or was followed by a fatal termination.

Hence we are led to infer that hogs may become infected by this noxious flesh-worm without ever showing the slightest symptoms of disease through life; and this was precisely the case at West Hartford. Again, a mild type of this trouble would never be noticed by any farmer in the state, and undoubtedly many cases of trichiniasis have occurred, which were treated for "Hog cholera" or "black tush."

Nearly all mammalia can be artificially infected with trichinæ, but our danger comes wholly from the porcine race. Swine are the bearers of this parasite which affects mankind. Hence, the necessity of more carefully studying the various diseases of the hog, and accordingly exercising greater care in the rearing of these animals, for the market, that our own tables may be protected and our lives prolonged.

HISTORY OF THE DISEASE IN MAN.

Though much had been learned concerning the natural history of this parasite, especially through the investigations of Leuckart and Virchow, yet Dr. Zenker of the Dresden Medical School supplemented these observations in a timely manner and threw new light upon the subject, in a medical point of view. He found, upon microscopic examinations, free and living trichinæ in the muscles of a servant girl who died in the hospital, at the age of twenty, of what was supposed to be a typhoid fever. She was taken ill January 12, 1860, and fell a victim to this strange malady within a month. Her symptoms were severe, and in some respect resembled rheumatism, with painful swellings of the limbs. The history of the case, therefore, was of more than usual interest to the profession, and excited not a little clinical inquiry, but no one mistrusted the cause of the trouble. It was soon ascertained however, after Zenker's post-mortem disclosure, that she had assisted in the making of sausage on the 21st of December previously, and that she had partaken of some of the raw meat only a few days before her illness. This led to his well-known investigation on the nature and pathology of trichiniasis, which has been so extensively published to the world, and has already crowned his life with a diadem of philanthropy, that scientific men will ever revere.

The discovery of this parasitic disease in man, which had undoubtedly existed for ages, aroused at once the zeal of professional experts and veterinarians, and was the dawn of a new era in sanitary science. Here was the key which has now successfully unlocked the mysterious history of many epidemics, that had heretofore baffled the medical wisdom of all nations to explain. With this helminthological revelation, human and comparative pathology joined hands to explore certain realms in the causation of disease, and thus point out the remedy that was destined to relieve the sufferings of millions of human beings that might fall victims to this parasitic malady.

The symptoms of trichinous infection in man will depend largely upon the quantity of diseased meat that has been eaten, and also upon the stage of the malady. The invasion of the disease is marked by local irritation within the intestinal tract, caused by the liberation and development of the encysted trichinae that the patient has eaten. The millions of new-born worms that immediately follow give rise to nausea, loss of appetite, inflammation of the mucous surface of the bowels, and diarrhoea. Peritonitis may sometimes occur, from the perforation of the intestinal walls, in the escape of the larval parasites.

The second stage is characterized by general symptoms, muscular pains, rheumatism, etc., occasioned by the migration of the worms in the various parts of the body. There is great soreness, œdema, and stiffness of the muscles. Lassitude and profuse sweating not unusually occur in severe cases, and in this respect it resembles typhoid fever, for which it has many times been mistaken. This stage commences in about ten days from the first illness, and lasts four or five weeks.

In the third phase of the malady the trichinae have become encysted, the fever, soreness, and inflammation begin to abate, and the patient is in a fair way to recover. In many cases there is a complete restoration to health again, but often it leaves the system in a very prostrate condition, according to the amount of muscular lesion that has taken place.

Those suffering from a mild and insidious form of the disease are not unfrequently able to walk about, yet feel tired and exhausted. They may have a good appetite, and the bowels regular. In such cases the pulse is but slightly disturbed, and the patient sleeps soundly, as though nothing was the matter. Lancing pains soon are felt, especially in the neck and extremities. In fact, they are neither sick nor well, observes Leuckart, and yet they feel strangely and are unable to account for it. Following this transition stage, the pains become more intensified in certain muscles, and with more or less swelling.

Thus a chronic febrile condition sets in, differing from the usual type only in the absence of *acute* symptoms. In other cases a high fever occurs suddenly, with severe bronchial catarrh, and the patient often succumbs to such an attack in a few days, which of course is very terrifying to the friends, and especially so when it shall have been ascertained that the whole cause of the trouble is

this dreaded parasite, consumed with the meat from a fine domestic hog, reared on his premises and fed by his own hands.

MEANS OF PREVENTION.

Although the swine of every land may occasionally be infected with this noxious parasite, still the frequency of its transmission will depend in a great measure upon the habits of the people. In those countries where the practice of eating raw pork and sausages so extensively prevails, of course the parasites contained in the flesh will be transported to the human stomach unmolested, but no fears need be anticipated from even the free use of pork if it has been subjected to a sufficient degree of heat in the process of cooking, to destroy every germ of animal life; then it would be as harmless from this cause as fish, beef, or venison.

The ravages of this loathsome malady from the use of diseased pork are not confined to any country, and I believe it prevails more extensively than is generally supposed. Dr. George Sutton of Aurora, Indiana, who has been examining pork killed in the State, says he has found from three to sixteen per cent. of the hogs affected with this disease—differing in various localities—and that, taking the rate at four per cent., we have put upon the market from the Western States 221,184 diseased hogs, or about 44,296,800 pounds of infected meat, every ounce of which might produce disease.*

The Committee of the Chicago Academy of Science has shown that the percentage of swine infected by the trichina in the Western States is greater than in Germany, still, the disease is of rare occurrence on this side of the Atlantic compared to the old country; and we can ascribe no cause for the greater prevalence of this disease in Germany, except it be the habit of eating their ham or sausage in the raw or uncooked state.

Thus our only safety from the use of pork, which is always more or less liable to contain trichinae, from any portion of the country, is through *cooking*. Salting and smoking, unless long continued, have but little effect upon the vitality of these parasites. Raw ham or sausage should never be allowed upon a sanitary bill of fare; and even boiled ham, when large and fashionably prepared, as seen in many of our eating saloons to-day, not unfre-

* A report on Trichinosis, from the Transactions of the Indiana State Medical Society, 1875.

quently may contain these living worms. Hence our lives may be prolonged and our health improved by more attention being given to the domestic duties of the household. Then will all meats be served upon our table in a manner both to nourish and promote our happiness.

As another means of prevention, special attention should also be directed to "village hogs," that are allowed to roam at large and thus become public scavengers. In fact, the known habits of swine to root in their own excrement affords another means for the spread of this contagious malady. If one hog in a pen or drove becomes infected, the rest are almost sure to be in due time; for that the trichinæ may pass away with the discharge from the bowels, and thus be taken up by the others, there can be no doubt.

More attention, also, should be paid to the cleanliness of our public slaughter houses, with a view of controlling the ravages of all infectious and contagious diseases among our domestic animals, which often arise from want of sanitary regulations in their management. Besides, few butchers have the necessary knowledge to guard the people against the possibility of infection in the meats they vend. All public abbatoirs, therefore, should be under the supervision of a competent veterinary surgeon, who should have full control of our meat supplies, and thus be able to prevent an infected article from ever reaching the table even of a single plebian family.

SANITARY INSPECTION.

The actual recognition of this parasite in the flesh of swine during life, observes Leuckart, is of great importance. The symptoms in many of the artificial cases of infection are not characteristic. The appearance of the capsule has been claimed to be diagnostic, but when present its color is not alone sufficient to distinguish it from the surrounding tissues, unless calcified. If the muscle is quite *red*, however, trichinæ are very liable to be present.

Accordingly the microscope is our only means of determining their presence beyond a doubt. This investigation is best made during life, by harpooning a piece of muscle for the purpose, and the regions of the neck, shoulders, and fore-limbs seem to have the preference. But in the dead animal, Leuckart has found the diaphragm to contain the largest number of young trichinæ, and the tenderloin, larynx, and tongue are also easily accessible to these wandering parasites.

In severe cases of infection the muscles of the posterior extremities are also found to contain them, but when trichinæ cannot be found in the anterior parts it is useless to look for them in the hind legs. Trichinæ are frequently more abundant at the extremities of the long muscles than in the central portions, consequently these parts should be chosen for examination.

To get the best view of the encapsuled worm, lay bare the fibers by separating them from the surrounding connections. Take up a small portion with the forceps and thus separate in the direction of the fibers, a portion of tissue not more than a millimeter (.03 of an inch) in thickness. Avoid the blood vessels and nerve filaments, and select a sample near the tendon, as the trichinæ are most abundant in that portion. Place the specimen on a glass slide and with mounted needles spread it out to double its width. Moisten the slip with a solution of caustic potash, says Leuckart, and after a few moments, when the muscle becomes clear, lay on a cover of thin glass, flatten out the sample, under pressure, and remove the air-bubbles. By holding the specimen now towards the light, capsules can be seen by the naked eye, as small, clear specks, as shown in our first wood cut.

These parasites vary in appearance, according to their age and degree of development, but their absence cannot be relied upon from the results of a single specimen examined. When the cysts are calcified they can be readily seen by the unaided eye, as little white points in the muscular tissue.

In all such microscopic examinations of infected meat great care should be taken to have the glass-slips and covers free from all foreign substances, specks, etc., which have so often been mistaken and confounded with the object in question.

The claim is made that the southern hogs that roam free through the woods do not have trichinæ, so that if this be true, the lovers of southern bacon can indulge their taste freely. An ounce of hog's muscle has been found to contain 85,000 trichinæ, and forty millions were estimated to be in the body of a man who died of trichinosis. Thus far Germany has been ahead of any other country in the record of cases and endemics.

The following table shows the instances of trichiniasis in the United States.*

*I am indebted to the Report of Dr. W. C. W. Glazier, prepared for the U. S. Marine Hospital service, for many facts and references not otherwise obtainable, and for the table of localities.

TRICHINOSIS IN THE UNITED STATES.

Year.	Locality.	Reporter.	Number of cases.	Number of deaths.	Reference.
1856	Iowa.....	Dr. Timm.....	1	1	Virch. Arch., Bd. xxix.
1864	New York.....	Schmelter.....	4	1	Am. Med. Jour., February 20, 1864.
1864	do.....	Professor Dalton.....	1	.....	Trans. N. Y. Acad. Med., 1864, N. Y. Times.
1864	do.....	Dr. Voss.....	4	1	Aiken Prac. Med., vol. i, p. 160.
1864	Cheektowaga, N. Y.....	Dr. Krimbein.....	2	2	Buffalo Med. and Surg. Jour., June, 1864.
1864	Manilla, N. Y.....	Dr. Dwyler.....	6	.....	Am. Jour. Med. Sci., July-September, 1864.
1865	Massachusetts.....	A. Sawyer.....	2	.....	Best. Med. and Surg. Jour., 1865, p. 46.
1865	N. Y. (in hospital).....	Dr. H. Copeland.....	1	.....	From Pub. Sci. Jour., 1871; case diagnosed enteric fever.
1865	Linn County.....	Dr. H. Wilson.....	6	.....	St. Louis Med. Rep., 1866, Chicago Med. Jour., 1866.
1866	Marion, Linn County, Iowa.....	Dr. H. Restine.....	9	5	N. Y. Med. Rec., August, 1866, Flint's Prac., p. 487.
1867	New York Hospital.....	Dr. E. C. Seguin.....	1	1	N. Y. Med. Jour., vol. iii, 1868, p. 116.
1867	Massachusetts.....	.....	6	.....	Med. Times, April 20, 1867, p. 431. Davaine. Cobbold, p. 169.
1869	Albany, N. Y.....	Dr. Hun.....	1	.....	Trans. N. Y. State Med. Soc., 1869, p. 157.
1870	Saxtonville, Mass.....	.....	2	1	Lond. Lancet, 1871, p. 315.
1870	Lowell, Mass.....	.....	2	.....	Do.
1870	Marengo, De Kalb County, Ill.....	.....	8	3	N. Y. Med. Jour., xi, 1870, p. 107.
1874	Aurora, Ind.....	Dr. Sutton.....	.....	.....	A report on trichinosis as observed in Dearborn County, Indiana, in 1874; re-print from Trans Ind. State Med. Soc., 1875.
1874	Detroit, Mich.....	Dr. Keiler.....	1	1	Mich. Bd. Health Rep., 1875.
1874	Fort Haron, Mich.....	Dr. Northup.....	4	1	Proceedings Med Soc., county of Kings, 1879.
1879	Brooklyn, N. Y.....	Dr. William Madden.....	5	2	Letter to Surg. General M. H. S.
1879	Marionville, N. J.....	Dr. E. J. Bergen.....	4	1	American Practitioner, September, 1879, p. 135.
1879	Milford, Ind.....	E. P. Gilpin.....	5	3	N. Y. paper.
1880	Newark, N. J.....	.....	4	.....	Number of cases a long time ago.
(*)	Fridgeton, Conn.....	Prof. J. F. Sanford, Yale College.....	.....	.....	Epidemic in German family a long time ago.
(*)	Newark, N. J.....	Dr. A. Hall.....	4	.....	Diagnosis not confirmed by post mortem.
(*)	Baltimore.....	Prof. Michael.....	.....	.....	Microscopist, N. A. Jour. Homoeop., No. viii, p. 317, N. Y. Free Press.
(*)	New York.....	Specimen shown to Dr. Thayer.....	.....	.....

* Date uncertain.

BIBLIOGRAPHY OF THE SUBJECT.

Besides the book notices already given with the text, we here-with append a series of standard works for reference.

Supplement to the Entozoa, containing his experiments on *Trichina Spiralis*, by T. S. Cobbold, M.D., F.R.S., roy. 8vo, London, 1869. Also, his able work on the Parasites of Man and Animals, 8vo, 1879.

Human Entozoa; comprising the different species of worms found in the intestines and other parts of the body, by William A. Smith, M.D., F.R.C.P., London, 1863.

Traité des Entozoaires et des Maladies Vermineuse de L'Homme et des Animaux Domestiques, par C. Davaine, Paris, 1860.

Anatomie Pathologique du Corps Humain, avec figures coloriées, par J. Cruveilhier, Paris, 2 vols., folio, 1829-42.

Drs. Bristowe and Rainey on *Trichina Spiralis*, with several fine plates, in Trans. Pathological Society of London, vol. 5, 1854.

Micrographic Dictionary, on *Trichina Spiralis*, third edition, by Griffith, Henfrey, and others, London, 1875, with fine plate.

Internal Parasites of Domestic Animals, with illustrations, by Prof. A. E. Verrill, Hartford, 1869.

Trichina Spiralis, in Manual of Veterinary Sanitary Science and Police, by George Fleming, F.R.C.V.S., London, 1875, vol. 2.

Dr. John Gamgee on *Trichinae* in Our Domestic Animals in Health and Disease, vol. 2, 1867.

See, also, an elaborate article on the subject in Ziemssen's *Cyclopædia of the Practice of Medicine*, vol. 3.

Leuckart, Die Menschlichen Parasiten, Zweiter Band, 3 Lieferung, Leipzig, 1876.

Étude sur le *Trichina Spiralis* par H. Kestner, Paris, 1864.

Report on *Trichinae* and *Trichinosis*, prepared under direction of the Supervising Surgeon-General of the Marine Hospital Service, by C. W. C. Glazier, M.D.

Leuckart, Die Trichinen, Leipzig, 1866.

Transactions American Public Health Association, Ninth Session.

The last six to be found are in Secretary Chamberlain's office, and the remainder can be seen in the library of the author.

EXPLANATION OF PLATE.

Showing the different stages of development of the *Trichina spiralis*.

Fig. 1.

This cut gives a bird's-eye view of the migration of the parasite, showing the comparative size of the worm and of the muscular fiber, and the extent that the tissues often become involved. The parasite is shown free, entering the muscular fibres, and fully encapsuled. The striations of the muscular fibres are plainly shown. The illustration is drawn from an actual specimen of human muscle infected by trichinæ. The one selected was the masseter, one of the strong muscles of the jaw. This is from Kestner.

Fig. 2.

Shows an encysted worm in the advanced stage, with signs of fatty degeneration in the muscular fibres at the poles of the capsule. The capsule here has become calcified either wholly or partially, and is distinct from the muscular tissue. From Leuckart.

Fig. 3.

Exhibits a male, highly magnified. This is enlarged 150 diameters, and represents the parasite fully grown, from Kestner.

Fig. 4.

An adult female, showing its relative size compared with the male, the contained ova, and the discharge of the living worm from the cloaca, situated near the anterior part of the parasite. The embryos are seen through the walls, and the trichinæ at birth, magnified 150 diameters, from Kestner's plate.

Fig. 5.

Encapsuled worms, showing the walls of the cyst, the parasite coiled upon itself, and the great engorgement of a muscle. This shows how thickly the parasites may be encapsuled. The frequency varies very much in different muscles. From Leuckart.

Fig. 5.



Fig. 3.



Fig. 1.



Fig. 2.



Fig. 4.



